Abstract

This thesis deals with the development of a new adaptive algorithm for three-dimensional fluid flows based on a residual error estimator. The residual, known as the $\Re$–parameter has been successfully extended to three dimensions using a novel approach for arbitrary grid topologies. The computation of the residual error estimator in three dimensions is based on a least-squares based reconstruction and the order of accuracy of the latter is critical in obtaining a consistent estimate of the error. The $\Re$–parameter can become inconsistent on three–dimensional meshes depending on the grid quality. A Zero Mean Polynomial (ZMP) which is k–exact, and which preserves the mean has been used in this thesis to overcome the problem. It is demonstrated that the ZMP approach leads to a more accurate estimation of solution derivatives as opposed to the conventional polynomial based least-squares method. The ZMP approach is employed to compute the $\Re$–parameter which is then used to derive the criteria for refinement and derefinement. Studies on three different complex test problems involving inviscid, laminar and turbulent flows demonstrate that the new adaptive algorithm is capable of detecting the sources of error efficiently and lead to accurate results independent of the grid topology.